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# EFFECT OF SAND OR SOIL AS A DIETARY COMPONENT ON PHOSPHORUS UTILIZATION

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ABSTRACT
Experiment was conducted to determine the effect of sand or soil ingestion on P balance in Goats. 12 Africa Dwarf goats (44.9kg) were fed a based diet containing 10% of either soil (the mould in which plants grow - the mixture of disintegrated rock and organic material which nourishes plant) or sand (a mass of rounded grains of rocks) in a completely randomized design. Animals were injected iv with a single does of .5cm; of $^{32}$p as orthophosphoric acid to facilitate determination of metabolic fecal P. Total fecal and urine collections were made for 7 d and blood samples were obtained three times. Levels of A1, Fe and Mn for the sand diet were 46, 199 and 36ppm, and for basal diet 147, 88 and 35ppm. Goats fed the sand diets had lower (P>.05) serum P concentration than goats fed soil diet. Total and metabolic fecal P were higher (P > .05) and urinary P lower (P < .05) for goats fed sand resulting in lower (P > 01) apparent and true P absorption and P balance for these two diets compared with the soil diet.

KEY WORDS: Soil ingestion, phosphorus, Aluminum, iron, goat.

## INTRODUCTION

Goat and cattle on pasture ingest variable amounts of soil during grazing. Field and Purves (1964) reported that during winter grazing, sheep ingested soil at levels up to 15% of total dry matter intake and suggested that ingested soil is a source of minerals to grazing ruminants. Healy (1968) and McGrath (1982) indicated that average soil ingestion can reach 1,600g/d for cattle and 400g/d for sheep and that probably one-half of the annual intake occurs during the winter.

Phosphorus deficiency is found frequently in tropical grazing areas around the world (Cohen, 1980), and may be the first limiting mineral under many grazing conditions. Aluminum and Fe in ingested soil may interfere with dietary P utilization (Rosa *et al;* 1982) and this effect could be critical if the animals were in a borderline P deficiency. The present experiment was conducted to investigate the effect of ingestion of soils of different mineral composition on performance, blood variables and P metabolism in Africa Dwarf goat.

TWELVE MATERIALS AND METHODS: West Africa Dwarf goats, initially averaging 44.8kg, were assigned to two treatment groups in a completely randomized design. Experimental diets contained 10% of either sand (control) or soil as shown in table 1. Washed sand and soil were screened to pass a No. 60 screen (sieve opening – 250µm) before mixing with the basal diet.

Goats were confirmed in metabolism stalls during a 21 – day period. The basal diet was fed the first 7d and experimental diets the next 14d. Feces and urine were collected the final 7d. A single dose of .5mci of $^{32}$P as carrier-free orthophosphroic acid was injected into three goats of each treatment group on the first day that experimental diets were fed.
Feed offered was limited to 900g/head daily and tap water was provided and libitum. Feed offered, feces and urine were weighed and sampled daily and composted separately for each goat. Blood samples were

obtained by jugular puncture the day before feeding the experimental diets and the last day of the balance trial. Goats that were injected with $^{32}P$ were bled three times during the balance trial to determine specific activity of serum P. Dry matter and ash determination were made in duplicate (AOAC, 1984). Feed was analyzed for Al, Ca, Mg, Fe, Cu, Zn and Mn by atomic absorption spectrophotometry, and P by colorimetric method. Determinations of Ca, Mg and P in serum were made following the same methods. Radioactivity in serum, urine and feces was measured in a liquid scintillation counter (Beckman LS 335) and results were corrected for quenching using an internal standardization method (Long, 1979) endogenous P excretion was determined from corrected counts in serum and feces.

Table 1: composition of Basal Diet

| Ingredient | % |
|---|---|
| Corn meal | 34.0 |
| Cotton seed hulls | 30.0 |
| Corn starch | 26.3 |
| Sugar cane molasses | 3.0 |
| Soybean meal | 2.0 |
| Cassava meal | 2.0 |
| Urea | 2.0 |
| Salt | 1.0 |
| Ground limestone | .2 |
| Total | 100.0 |

Table 2: Chemical characteristics of sand and soil

| Item | Sand | Soil |
|---|---|---|
| Ph($H_2O$) | | 4.8 |
| Ph(In KCl) | | 3.9 |
| Exchange elements | | Meq/100g |
| Al | | 3.19 |
| K | | .14 |
| Mg | | .18 |
| Ca | | .08 |
| P | | .20 |
| Total elements | % | |
| Al | .06 | 6.15 |
| Fe | 1.62 | 3.05 |
| Na | .56 | 1.30 |
| K | .96 | .20 |
| Mg | .31 | .06 |
| Ca | .75 | .03 |
| P | .03 | .03 |
| | ppm | |
| Mn | 53 | 1,390 |
| Cu | 30 | 138 |
| Zn | 26 | 90 |

Correlations among excretion, absorption and retention were calculated and all data were analyzed by the statistical Analysis system procedures (SAS, 1979). Duncan's multiple range test was used to compare means.

RESULTS

The chemical composition of the diets (Table 3) showed that changes in mineral composition occurred as a consequence of introducing 10% soil or sand. Ash, Al, Fe, Zn and Mn were higher for the experimental diets compared with basal diet. Ash was higher in the sand diet and lower in the soil diets. The sand diets were lower in Aluminum and Cu. Phosphorus, Ca and Mg concentrations were similar in the experimental diets and basal diet.

Table 3: Mineral composition of experimental Diets[a]

| Ash | P | Ca | Mg | |
|---|---|---|---|---|
| | | g/100g | | |
| Sand | 15.1 | .15 | .19 | .10 |
| Soil | 12.5 | .16 | .19 | .10 |
| | | ppm | | |
| Al | | 346.0 | 7,504.0 | |
| Fe | | 199.0 | 1,194.0 | |
| Mn | | 36.2 | 40.7 | |
| Cu | | 7.8 | 10.6 | |
| Zn | | 46.2 | 51.8 | |

[a]Dry matter basis

Table 4: Effect of sand or soil ingestion on serum minerals in goat [a]

| Item | Sand | Soil | SD[b] |
|---|---|---|---|
| | mg/100ml | | |
| Phosphorus | | | |
| Final | 7.33[c] | 9.08[d] | 1.09 |
| Change | -36 | 1.66 | |
| Calcium | | | |
| Final | 9.25 | 8.91 | |
| Change | .20 | -.08 | .52 |
| Magnesium | | | |
| Final | 2.23 | 2.23 | |
| Change | .08 | .11 | .24 |

[a] Each value represents the means of six goats, [b] Standard deviation calculated from radical mean square
c[d] Means in the same row with different superscripts differ (P < .05)

Serum P increased 1.66 mg/100ml for the goats fed soil diet but decreased to .36mg/100ml for the control group metabolic fecal P excretion was lower (P<.05) for soil diet than the sand (control) diet phosphorus true absorption with the soil diet (69.6%) was greater (P<.01) than the sand (54.5%) were correlated (r = 91). Phosphorus retention for the soil diet (203mg/d) was greater (P>.01) than that for the sand diet (39mg/d). Phosphorus retention was correlated with the apparent absorption (r = .92, P<.01) and the true absorption (r =.79, P<.01) of this element.

Soil is apparently not as effective in depressing P utilization in animals as are Al and Fe when present in more soluble compounds. Plasma P in goats was not influenced by 405 or 300ppm AL fed as aluminum

sulfate (Thompson *et al;* 1959) but was decreased at 2,000ppm Al as aluminum chloride (Valdivia *et al*; 1982). Standish *et al* (1971) observed a depression in serum P in cattle when 1,000ppm Fe as ferrous sulfate was fed. Dietary levels of Al for the diets containing soil in the present studies were about 7,500 and 16,600pmm and levels of Fe were 1,200 and 7,200 pmm.

There was no difference in P absorption or retention with relatively small amounts of soil 450 or 900g, were added to diets for cows (Miller *et al,* 1977).

It is concluded from the present study that soil ingestion may adversely affect the utilization of P by goat mainly through its content of Fe and Al. This effect would be a function of the soluble levels of these elements in soil. Results, however, indicated that effects are of much smaller magnitude than what would he expected if soluble compounds of Fe and Al were provided.

Table 5: Effect of sand and soil on phosphorus absorption and retention in goats

| Phosphors | Sand | Soil | SD[a] |
|---|---|---|---|
| Intake, mg/d[b] | 1,010 | 1,020 | 190 |
| Fecal, mg/d[b] | 930[d] | 700[e] | 150 |
| Apparent absorption, %[b] | 7.9[f] | 31.4[g] | 11.22 |
| Metabolic fecal, mg/d[c] | 470[d] | 390[e] | 80 |
| True absorption, %[c] | 54.5[f] | 6.56[g] | 4.93 |
| Urinary, mg/d[b] | 41[d+] | 117[c] | 70 |
| Net retention, mg/d[6] | 39[f] | 203[g] | 105 |

[a] Standard deviation calculated from the residual square, [b] Each value represent the mean of six goats
[c] Each value represents the mean of three goats, d:[e] Mean in the same vow with different superscripts differ (P<.05), f,9 Mean in the same row with different superscript differ (P<.01)

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